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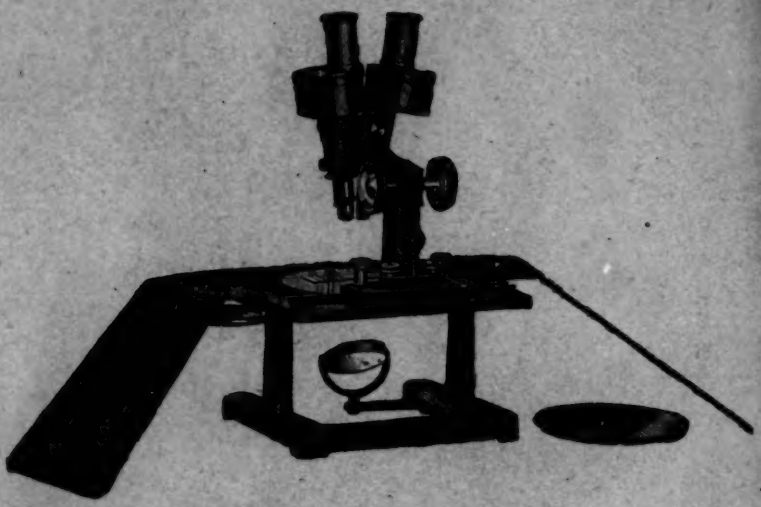

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Vol. 46 No. 5

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MAY, 1919

Mucilage or slime formation in the cacti

E. GRACE STEWART

(WITH PLATE 8)

The cellular processes involved in the formation of plant slimes, of gums, and of resins are subjects which have attracted the attention of many investigators.

Pfeffer (**16**) in his "Physiology of Plants" states in general that mucilage may be formed by synthesis or by decomposition as when the cell wall becomes mucilaginous. He also accepts the doctrine that mucilage is often formed in the interior of the cell. Karsten (**7**) claims that the formation of cork, gum, slime, etc., 's due to processes of intussusception going on in the protoplasm. Tschirch (**21**) has emphasized the conclusion that in the cell wall there is a specialized layer next the cuticle which he calls the resinogenous layer and in which so-called secretions are formed.

Of the earlier investigators, Cramer (**2**), Von Mohl (**22**), Nägeli (**15**), Hofmeister (**6**), Wigand (**24**), Schlacht (**17**), Frank (**4**), and De Bary (**3**), were of the opinion that mucilage building is a disorganization process occurring in the cell wall. The transformation into mucilage they all agreed began in the outer part of the wall and worked toward the inside. Hofmeister (**6**) believed that the cell walls became thickened by the apposition of new layers, hence the striated appearance of the jelly. Frank (**4**) found that in the bulbs of orchids mucilage developed from the cell contents in a crystal-bearing cell about a bundle of crystals which finally disappear. In other plants he thought the gum was formed

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from the cell wall. He noted that at first these gum cells contained starch grains, many of which appeared corroded.

Prillieux (**17**), in the gummosis of fruit trees, claims that gum may appear in cells whose walls do not show a trace of disorganization. The starch grains simply disappear and small masses of gum take their place. Haberlandt (**5**), in his treatment of the anatomy of cells containing slime from a morphological viewpoint, considers the slime masses in Malvaceae, Marchantiaceae, Cactaceae, and Lauraceae to be a very strongly thickened and finely stratified cell membrane. According to Haberlandt (**5**), in such cases the primary cell wall, as a rule, does not degenerate.

In 1893 Walliczek (**23**), working under Tschirch, concluded that there were cell content slimes as well as membrane slimes, but that cell content slime had been proved only for *Orchis* and *Symphytum*. He found that the cell content slimes appeared as homogeneous masses, while the membrane slimes were stratified. The following year Schilling (**19**), working on the question of slime formation in water plants, decided that slime building went on at the expense of the cell wall and that at the end of the process only a very thin shell was left about the cell.

Butler (**1**), studying gummosis in fruit trees, accepts the view that the process of gum formation is a degeneration of the cell wall. The essential factors are relative rate of growth and water supply. Dissolution begins in the secondary lamella and almost coincidently in the primary membrane, and the cell contents are at no time actively concerned in gum formation.

We now turn to a consideration of the investigations that have been made relating to the formation of mucilage in the cacti. These plants have been rather exhaustively studied for many years but so far comparatively little cytological work has been done upon the group. In most of the forms mucilage is very abundant. The question as to the method of its formation was discussed first by Meyen (**14**) in 1837. He reported that he found mucilage in the intercellular spaces of the cacti and in some cases he found mucilage ducts in great numbers. He concluded that a direct transformation of cell contents into mucilage took place and showed a figure with cells filled with mucilage.

Two years later Schleiden (**20**) published the results of the

first attempted cytological study of the cacti. He noted that the contents of the parenchyma cells was primarily "starch or mucilage in globules." Both were almost always surrounded with chlorophyll. In almost all species which he studied he reported that he found two to six times enlarged cells distributed in the cortex and in the central parts of the stem, all of which were totally filled with a vegetable jelly with a characteristic type of organization. These mucilage-filled cells he said he could not find in *Rhipsalis rhombea*, but in their place he found large cells filled with starch.

Between this work of Schleiden (**20**) in 1837 and that of Lauterbach (**8**) in 1889, no very full study of the mucilage of the cacti is reported. Cramer (**2**) described the slime of the cacti arising as a thickened layer on the cell wall, thus proving, as he held, its close relationship with cellulose. He found these continuous thickening layers in especially large single cells. He believed that by rupture the wall layers became irregular and showed such a structure as Schleiden (**20**) described.

Schacht (**18**) studied old stems of *Opuntia Ficus-indica* and reported gum-like tragacanth contained in canals. He believed that this gum arose as the result of a disorganization of the cell wall. Wigand (**24**) observed that certain parenchyma cells in the cacti, which were of somewhat greater diameter than their neighbors, were filled with a homogeneous colorless slime. De Bary (**3**) noted that this mass of mucilage had the structure of a very thick, abundantly, and delicately stratified cell wall. He concluded that it was the cell wall thickened at the expense of the internal cavity of the cell.

From his investigations Lauterbach (**8**) was led to believe that there are two methods by which the mucilage is formed, one holding true for *Opuntia*, and the other for the remainder of the cactus groups. In the *Opuntia* the mucilage arises in a cell containing a small crystal of some oxalate. This crystal, as he thought, seemed to stimulate the growth of the cell. Later the nucleus and crystal might appear suspended on strands of cytoplasm in the midst of the cell and mucilage would then begin to appear in the periphery of the protoplasm.

In the other cacti he held that the mucilage also arose in the

periphery of the protoplast in the plasma membrane, but that no crystal was present. The cytoplasm is pressed toward the center of the cell as the mucilage increases until it remains as a mere remnant in the interior. By the use of a strong sugar solution he was able to make the mucilage surrounded by its delicate plasma envelope pull away from the wall. He observed striations in the mucilage, but made no attempt to account for their origin.

Walliczek (**23**) claims that the mucilage of the cacti arises as a secondary thickening of the primary cell wall. He also states that it does not give a cellulose reaction in the moment of its formation nor later. He suggests that the stratification in most cases is dependent upon a different water content in the layers. This stratification, he says, shows best when the material is preserved in alcohol and water added later.

Longo (**11**, **12**) holds that the peculiar structure of the mucilage which Walliczek describes is due to the action of the alcohol which, he believes, withdraws water from the mucilage. He used fresh material as well as alcoholic preparations and found that the mucilage was not the result of a transformation of the cellulose membrane, but came from the protoplasm, showing the characteristics of mucilage as soon as it appeared. He does not agree with Lauterbach (**8**) that the mucilage is produced in droplets in the parietal protoplasm. He finds it appearing between this and the thin cell, wall of cellulose, which never undergoes any modification.

As to whether the mucilage arises from the wall or from the protoplasm, the opinions seem to be about equally divided, but Walliczek, Lauterbach, and Longo all agree that it is accumulated between the plasma membrane and the cell wall. In this connection I might say that in the present paper I have figured a case in which the wall between a mucilage cell and the neighboring cell shows the middle lamella with the wall of equal thickness on each side of the lamella, which is good evidence that the wall is not affected by the formation of the mucilage.

For the most part I have studied *Rhipsalis rhombea* (from the New York Botanical Garden), the species in which Schleiden (**20**) said he could not find any cells filled with mucilage. Owing to the incompleteness of his record it is impossible to determine whether

or not his *Rhipsalis rhombea* was identical with the species which I used. My plants are all from greenhouse sources and were probably introduced from Europe. Besides *Rhipsalis rhombea*, I have used *Rhipsalis pachyptera* and *Rhipsalis Houlletiana*, brought from France, likewise *Opuntia inermis* and *Pereskia Pereskia*.

In the leaves of the flower buds of *Opuntia* and of *Rhipsalis*, the mucilage cells are often so large and so numerous that in cross section these leaves seem to be almost filled with mucilage. With the Flemming triple stain the mucilage is colored blue, but is not so deep a blue as the starch grains. The mucilage is never, with the method I have used, of the same color as the wall surrounding it.

In the flower buds of *Rhipsalis* the large mucilage cells are abundant, not only in the floral leaves but also in the ovary wall, in some cases almost every cell being filled with mucilage. The mucilage cells are more numerous in the periphery than toward the center. Sections were made also of very young *Rhipsalis* stems. In these meristematic tissues there are numerous mucilage cells which are two or three times as large as the neighboring cells. The adjacent cells (FIG. 1) are typical vegetative cells containing a large central vacuole surrounded by a thin layer of cytoplasm adhering to the cell wall. In it are suspended the nucleus and a few starch grains.

On the other hand, in the large cell (FIG. 2), before any mucilage appears, the cytoplasm is much more dense. While it is spongy and vacuolated, there is no large central vacuole, neither is there any starch as a rule. The cells at this stage contradict entirely the possibility suggested by Lloyd (**9**) that their large size is due to imbibition of water by the mucilage which they contain. In the species studied by me, the cells destined to form mucilage reach a diameter two or three times that of adjoining cells before the mucilage begins to form in them. In FIG. 3 the protoplast is surrounded by a layer of mucilage, but its diameter inside the mucilage layer is approximately the same as that of the protoplast in Fig. 2.

The growth in these cells at this stage is true growth and not at all a mere matter of increased water content of a central vacuole.

As noted, their cytoplasm is especially dense and their nuclei and nucleoles proportionately large and very highly stainable, as shown in FIGS. 2 and 3. Their growth is plainly a matter of the accumulation of largely increased amounts of protoplasm preparatory to their secretory activity in the production of mucilage. While there is plenty of evidence for believing that the cells increase in size during the period of mucilage production and possibly after they are completely filled, their increase in size before there is any evidence of the presence of mucilage in them is equally clear. A glance at FIG. 2 will show the number of cells which adjoined this large cell and will give some idea of how these hypertrophied cells, which are to form mucilage, compare in size with their neighbors. FIG. 1 shows one of the ordinary cells adjoining a mucilage cell.

The mucilage or slime appears first as a very thin homogeneous film lying between the cell wall and the cytoplasm (FIG. 3). It stains but slightly and nowhere shows any conspicuous colloidal organization. In some of the older cells this layer persists about the periphery, while the remainder of the mucilage looks somewhat fibrillar and is also vacuolated (FIG. 5); in other cells the strands and vacuoles extend almost to the cell wall (FIG. 4).

As the amount of mucilage increases the cytoplasm is apparently crowded in toward the center of the cell, the nucleus and nucleole become smaller (FIG. 4), and while this is taking place both cytoplasm and nuclear-plasm become denser and lose their characteristically differentiated structure. Finally the nuclear membrane disappears and also the nucleole as such and the nuclear-plasm becomes merely a denser mass within the compressed and granular cytoplasm (FIG. 5). In the end nothing remains of the protoplasmic contents of the cell but an irregular highly stainable mass in about the middle of the cell. Sometimes this mass appears in section as a rather straight line, sometimes it has in section the shape of the letter Y. Many cells are also found which show no remnant whatever of the cytoplasm.

In the cells which are completely filled or nearly so, without exception the mucilage has the organization of a spongy substance full of vacuoles. Between and through these vacuoles there extend films, strands, or even threads, which radiate outward from

the cytoplasm in a rather characteristic fashion (FIG. 4). In some cells the mass of mucilage is rather homogeneous throughout, in many others it is reticulated and zoned (FIG. 7), so as to have led some investigators to believe that it is the much thickened and stratified cell wall.

While the cytoplasm with its included starch disappears entirely the cell wall nowhere shows a breaking down or disorganization. At the end of the process it is just as thick as at the beginning. In favorable cases the middle lamella is discernible and in such preparations the secondary wall is seen everywhere intact and is just as thick and no thicker on the side of the lamella next the mucilage cell than on the opposite side (FIG. 6). This would seem to show that the wall does not become disorganized or changed in any way as the formation of mucilage proceeds. The evidence all seems to point in one direction, namely, that mucilage in the cacti is formed not at the expense of the cell wall, but at the expense of the cytoplasm and nucleus. Neighboring cells, as well as the mucilage cell, perhaps, contribute of their content. They at any rate become flattened and contain very little cytoplasm (FIG. 5).

Haberlandt (**5**) has pointed out that in many cases slime containers may serve as water reservoirs and that it is not necessary to regard such slimy cell content as a useless excretion. He notes that the early differentiation of the slime cells in the vicinity of the growing point appears to point to their having a mechanical function in the growth process, and suggests that we have to do here with "Schwellapparaten."

This observation is perhaps borne out by experiments by MacDougal and others at the Tucson laboratory. It will be recalled that in his work on colloid hydratation and growth in the cacti, Long (**10**) reported that, in general, growth and swelling paralleled each other rather closely. Later MacDougal (**13**) found that agar, composed of pentoses presumably having some qualities identical with those of the plant mucilages, and both young and old disks of *Opuntia* will swell more when placed in distilled water or an alkaline solution than when placed in an acid solution. He found also that the apical parts of joints showed greater capacity for absorption than the basal portions. In a series of similar imbi-

bition experiments with joints of *Rhipsalis*, I have found that the greatest swelling in a majority of cases takes place in the apical region, the region of growth and of abundant mucilage cells.

We have then in the cacti a transformation of the content of many cells in the growing regions into a mucilage which, by absorbing water, may simulate true growth and may be of importance in conserving and regulating the supply of water for the growing cells themselves. As to the method of formation of the mucilage, as I have noted it in the cacti and more particularly in *Opuntia* and in *Rhipsalis*, it is the nucleus and cytoplasm that are the active agents. Apparently the cell wall is at no time involved in the process. The mucilage comes from the cytoplasm and the formation begins between the cell wall and the protoplasm, as Longo (**11**, **12**) points out. As the mucilage increases the nucleus and cytoplasm decrease in size and may entirely disappear, leaving the enlarged cell completely filled with mucilage.

That all resins, gums, and mucilages are similarly formed is in no sense suggested, but it is of interest that we have in these mucilage cells of the cacti a method of secretion much more like that of the gland cells of animals than the more familiar method by a resinogenous layer of the cell wall as found in many trichomes.

In concluding, I wish to express my gratitude to Dr. R. A. Harper of Columbia University, under whose direction this work was carried out, for his helpful criticisms and suggestions.

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LITERATURE CITED

1. **Butler, O.** A study on gummosis of *Prunus* and *Citrus*, with observations on squamosis and exanthema of the *Citrus*. Ann. Bot. **25**: 107–153. *pl. 7–10* + *f. 1–3*. 1911.
2. **Cramer, C.** Ueber das Vorkommen und die Entstehung einiger Pflanzenschleime. Pflanzenphysiol. Unters. **3**: 1–9. *pl. 27, 28*. 1855.
3. **De Bary, A.** Vergleichende Anatomie der Vegetationsorgane der Phanerogamen und Farne. Leipzig. 1877.
4. **Frank, A. B.** Ueber die anatomische Bedeutung und die Entstehung der vegetabilischen Schleime. Jahrb. Wiss. Bot. **5**: 161–200. *pl. 15, 16*. 1866.

5. **Haberlandt, G.** Physiologische Pflanzenanatomie. Leipzig. 1884.
6. **Hofmeister, W.** Uber die zu Gallerte aufquellenden Zellen der Aussenfläche von Samen und Perikarpien. Ber. Verhandl. Königl. Sachs. Ges. Wissens. **10**: 18–37. *pl. 1.* 1858.
7. **Karsten, H.** Uber die Entstehung des Harzes, Wachses, Gummis, und Schleims durch die assimilirende Thätigkeit der Zellmembran. Bot. Zeit. **15**: 313–321. 1857.
8. **Lauterbach, C.** Untersuchungen über Bau und Entwicklung der Sekretbehälter bei den Cacteen. Bot. Centralbl. **37**: 257–264, 289–297, 329–336, 369–375, 409–412. *pl. 2, 3.* 1889.
9. **Lloyd, F. E.** The colloidal properties of protoplasm: imbibition in relation to growth. Trans. Roy. Soc. Canada III. **11**: 133–140. *f. 1.* 1917.
10. **Long, E. R.** Growth and colloid hydratation in cacti. Bot. Gaz. **59**: 491–497. *f. 1, 2.* 1915.
11. **Longo, B.** Contributo allo studio degl' idioblasti muciferi delle Cactee. Ann. R. Ist. Bot. Roma **7**: 44–57. *1 pl.* 1897.
12. ————. Contributo allo studio della mucilaggine delle Cactee. Bull. Soc. Bot. Ital. **5**: 51, 52. 1896.
13. **MacDougal, D. T.** Imbibitional swelling of plants and colloidal mixtures. Science II. **44**: 502–505. 1916.
14. **Meyen, F. J. F.** Ueber die Secretionsorgane der Pflanzen. Berlin. 1837.
15. **Nägeli, C.** Die Stärkekörner. Pflanzenphysiol. Unters. **2**: 1–574. *pl. 11–26.* 1858.
16. **Pfeffer, W.** The physiology of plants. English Translation. Oxford. 1897.
17. **Prillieux, E.** Etude sur la formation de la gomme dans les arbres fruitiers. Ann. Sci. Nat. Bot. VI. **1**: 176–200. *pl. 5, 6.* 1875.
18. **Schacht, H.** Lehrbuch der Anatomie und Physiologie der Gewächse **2**. Berlin. 1859.
19. **Schilling, A. J.** Anatomisch-biologische Untersuchungen über die Schleimbildung der Wasserpflanzen. Flora **78**: 280–360. 1894. [Illustrated.]
20. **Schleiden, M. J.** Beiträge zur Anatomie der Cacteen. Mém. Acad. Sci. St. Pétersbourg (Sav. Étrang.) **4**: 335–380. *pl. 1–10.* 1839.
21. **Tschirch, A.** Chemie und Biologie der pflanzlichen Sekrete. Leipzig. 1908.
22. **Von Mohl, H.** Untersuchungen über die Entstehungsweise des Traganthgummi. Bot. Zeit. **15**: 33–43. 1857.

23. **Walliczek, H.** Studien über die Membranschleime vegetativer Organe. Jahrb. Wiss. Bot. **25**: 209–277. *pl. 11–13*. 1893.

24. **Wigand, A.** Ueber die Deorganisation der Pflanzenzelle, insbesondere über die physiologishce Bedeutung von Gummi und Harz. Jahrb. Wiss. Bot. **3**: 115–182. *pl. 5–7*. 1863.

Explanation of plate 8

FIG. 1. Cell from a section of a very young stem of *Rhipsalis rhombea* showing cytoplasm about the periphery containing starch grains and nucleus. Magnification about 1,900 diameters.

FIG. 2. Cell adjoining that shown in FIG. 1, showing the first stage in the formation of a mucilage cell. Nucleus and nucleole are much enlarged, cell is filled with cytoplasm, no starch is present. Magnification about 1,900 diameters.

FIG. 3. Cell from a section of a young stem of *Rhipsalis rhombea*. A large nucleus and nucleole are present and the cytoplasm is spongy, as in FIG. 2. A narrow border of mucilage like a thin film lies between the cell wall and the cytoplasm. Magnification 1,300 diameters.

FIG. 4. Mucilage cell from the ovary wall of a bud of *Rhipsalis Houlletiana*. The cytoplasm is compressed to a small mass in the center of the cell, its organization lost, but the nucleus still persisting. Alveolar mucilage fills the space between the cell wall and the cytoplasm. Magnification 600 diameters.

FIG. 5. Mucilage cell from a flower bud of *Rhipsalis pachyptera*. The cytoplasm lies in the central part of the cell and is very much compressed. A few starch grains still persist, but nucleus and nucleole are disintegrated. Magnification 600 diameters.

FIG. 6. Section of a wall between a mucilage cell and two adjoining cells in a flower bud of *Rhipsalis pachyptera*, showing the middle lamella. Magnification 1,100 diameters.

FIG. 7. Photograph of a section from a flower bud of *Rhipsalis pachyptera* showing the zonation in a mucilage cell. The darker central portion is cytoplasm, the striations in the mucilage being nearly parallel to it.

A taxonomic study of Dumortiera*

ALEXANDER W. EVANS

The genus *Dumortiera* was proposed in 1824 by Nees von Esenbeck for the reception of *Marchantia hirsuta* Sw. This species, which dates from 1788, was based on specimens from the mountains of Jamaica. Subsequent writers have assigned to it, however, a wide geographical distribution, its reputed range including most of the moist tropical and subtropical regions of the earth with extensions into certain temperate regions. According to the records the other species which have been referred to the genus are more restricted in their range, some of them having been reported from only one or two localities. These additions are not numerous, as the following complete list of species, arranged chronologically, will show:—

DUMORTIERA HIRSUTA (Sw.) Nees, 1824 (*Marchantia hirsuta* Sw., 1788);
D. SPATHYSII (Lindenb.) Nees, 1838 (*M. Spathysii* Lindenb., 1829);
D. IRRIGUA (Wils.) Nees, 1838 (*M. irrigua* Wils., 1833, *Hygropyla irrigua* Tayl., 1835);
D. NEPALENSIS (Tayl.) Nees, 1838 (*H. nepalensis* Tayl., 1836);
D. TRICHOCEPHALA (Hook.) Nees, 1838 (*Marchantia trichocephala* Hook., 1837);
D. DILATATA (Tayl.) Nees, 1847 (*Hygropyla dilatata* Tayl., 1844);
ASKEPOS BREVIPES Griff., 1849;
DUMORTIERA DENUDATA Mitt., 1861;
D. VELUTINA Schiffn., 1898;
D. CALCICOLA Campbell, 1918.

From this list three species may be at once excluded; they do not belong to *Dumortiera* and have already been transferred to their proper positions by writers. The species in question are: *D. Spathysii*, which is now regarded as a synonym of *Clevea Rousseliana* (Mont.) Leitg.; *D. dilatata*, a synonym of *Monoclea Forsteri* Hook.;† and *D. denudata*, the type species of the genus

* Contribution from the Osborn Botanical Laboratory.

† Leitgeb (7, p. 312) was the first to recognize that *H. dilatata* was a *Monoclea* and not a *Dumortiera*. He called it *M. dilatata*, supposing that it was distinct from *M. Forsteri*. His conclusions, unfortunately, were not based upon a study of the type material of *H. dilatata* but upon later New Zealand specimens, and his idea of *M. Forsteri* (in the opinion of Stephani) was gained from the American *M. Gottschei* Lindb., rather than from the true *M. Forsteri*. The type specimen of *H. dilatata* in the Taylor Herbarium shows conclusively that the species is a synonym of *M. Forsteri*.

Wiesnerella Schiffn. and now known as *W. denudata* (Mitt.) Steph. The remaining species have been the cause of much confusion from the taxonomic standpoint, and this is especially true of *D. hirsuta*, *D. irrigua*, *D. nepalensis* and *D. trichocephala*. To give some idea of this confusion it will be sufficient to quote from the writings of Schiffner and Stephani, two of the most prolific hepaticologists of Europe.

Schiffner, in 1893 (**9**, p. 36), estimated the number of species of *Dumortiera* as six, without enumerating them by name. He suggested, however, that they might all be forms of *D. hirsuta*, to which he attributed a range extending throughout all tropical countries. Under *D. hirsuta* he included the var. *irrigua*, a plant of Ireland, the Pyrenees, Italy and the southern United States. In another paper (**10**, p 275) published the same year, he listed the var. *irrigua* from Brazil. In 1899 (**11**, p. 387) he cited *D. hirsuta* somewhat doubtfully from Japan, the plants in question combining a densely papillose thallus with a bristly female receptacle. In 1900 (**12**, p. 25) he referred certain Javan specimens, which he had previously determined as *D. hirsuta*, to *D. trichocephala*, and stated that the true *D. hirsuta*, if it occurred in Java at all, must be much rarer than *D. hirsuta*. In 1902 (**13**, p. 274) he listed *D. irrigua*, this time as a species, from La Palma, one of the Canary Islands; and in 1909 (**15**, p. 482) he discussed the rhizoids of *D. irrigua* (in plants from Italy and Brazil) and of *D. hirsuta* (in plants from Java). He apparently now regards *D. irrigua* and *D. hirsuta* as distinct species and considers *D. trichocephala* a synonym of *D. hirsuta*.

Stephani's statements about the species in question leave an equally indefinite impression. In 1886 (**17**, p. 13; **18**, p. 94), he listed *D. hirsuta* from the African islands of San Thomé and Fernando Po; in 1888 (**19**, pp. 280, 300), from the West Indian islands of Hispaniola, Porto Rico and Dominica; in 1892 (**20**, p. 177), from Costa Rica; in 1895 (**22**, p. 304), from the African districts of Kamerun, Kilimanjaro and Usambara, and also from Queensland and northern New Zealand;* in 1897 (**23**, p. 78; **24**, p. 842), from Japan and the Hawaiian Islands. In 1894

* The New Zealand records seem to have been based on *D. dilatata* (see page 167, footnote); this species, for a time, was supposed to be a synonym of *D. hirsuta*.

(**21**, p. 6) he definitely recognized *D. irrigua* as a species, basing his observations on Italian material and emphasizing the impossibility of uniting it with *D. hirsuta*, and in 1897 (**23**, p. 78) he listed *D. irrigua* from Japan. In the same year (**24**, p. 842) he listed both *D. nepalensis* and *D. trichocephala* from the Hawaiian Islands. In his revision of *Dumortiera*, published in 1899 (**25**), he recognized the validity of *D. hirsuta* and *D. trichocephala* but included *D. nepalensis* and *D. irrigua* among the synonyms of *D. hirsuta*. This revision apparently represents his latest views. In it he restricted *D. trichocephala* to Asia and Oceanica, citing specimens from Tonkin, Birma, Java, Tahiti and Samoa, as well as from the Hawaiian Islands. He ascribed to *D. hirsuta* a much wider distribution, giving as localities many of those mentioned above and also the following: Mexico, Jamaica, Guadeloupe, Colombia and Brazil; Reunion; Nepal and Java; Tahiti; Ireland.

The divergent views of Schiffner and Stephani and the changes which these views have undergone are no more perplexing than some of the views advanced by other writers. They indicate that the characters distinguishing *D. hirsuta*, *D. irrigua*, *D. nepalensis* and *D. trichocephala* must be either untrustworthy or difficult to apply. The characters upon which *Askepos brevipes*, *Dumortiera velutina* and *D. calcicola* are based are likewise less satisfactory than might be desired and arouse the suspicion that variable and inconstant peculiarities have been too strongly emphasized. At the same time, as will be shown below, definite evidence has been presented that certain differential features may be transmitted from one generation to another, but whether these features are specific in value or merely indicative of varietal or racial differences is exceedingly difficult to determine. Even if they are regarded as specific, it must be admitted that the species of *Dumortiera* are much less clearly defined than those of most genera of the Marchantiaceae; they are little more than "small species," as this term is now employed in the literature of the bryophytes.

The characters most emphasized by writers in distinguishing the various species of *Dumortiera*, have been drawn from the size and method of branching of the thallus; from the structural features of its upper surface; from the structure and configuration

of the receptacles; and from the size of the spores. These characters may be taken up in order.

In its general aspects the thallus presents great uniformity. It consists of a flat, strap-shaped structure, with more or less undulate margins, and clings loosely to the substratum. According to Ernst (**4**, p. 163; *pl. 18, f. 1, 2; pl. 20, f. 18, 19*) the marginal undulations tend to be more pronounced in *D. trichocephala* than in *D. velutina* and are often accompanied by irregular indentations, but these vague differences are neither constant nor of great significance. The differences in size which have been described seem likewise very uncertain, although Campbell, (**2**, p. 331) in his account of *D. calcicola* emphasizes the narrow thallus, measuring barely 5 mm. in width. Quoting again from Ernst (**4**, p. 162) *D. trichocephala* includes larger forms on the whole than *D. velutina*, the thallus attaining a maximum width of 3 cm., but it includes also forms which are no wider than those of *D. velutina*. The size seems to be very strongly influenced by external conditions.

The branching of the thallus is usually dichotomous but sometimes ventral. The sexual receptacles are terminal, the branches bearing them being variable in length and normally limited in growth. Not infrequently, however, a sexual branch innovates at the apex, the innovation growing in the same direction as the branch and broadening out from a stalk-like base. Such an innovation is usually found in connection with a male receptacle or a female receptacle which has failed to be fertilized; but even a sterile branch, the growth of which has been arrested in some way, is sometimes induced to innovate. Apical innovations in *Dumortiera* have commonly been regarded as somewhat abnormal, caused perhaps by unfavorable environmental conditions. In *D. calcicola*, where they occur more regularly, at least on sexual individuals, they give rise to jointed sympodial systems of very striking appearance and have been emphasized by Campbell (**2**, p. 334) as a specific peculiarity. Unfortunately similar sympodia have been recorded by Schiffner (**10**, p. 275) in specimens of "*D. hirsuta*" from New Guinea and by Ernst (**4**, p. 161) in specimens of *D. velutina* from Java, so that they are by no means confined to *D. calcicola*.

In its histological features the thallus differs strikingly from most of the other genera of the Marchantiaceae, since it lacks, either partially or completely, the usual dorsal epidermis and system of air-chambers. The simplification in structure which is thus exhibited is regarded as a derived condition, associated in some way with the usual moist and shaded habitat of the plants. By the earlier writers air chambers were supposed to be invariably absent. Taylor, indeed, in his account of *Hygropyla irrigua* (**26**, p. 391), described a system of branched and anastomosing lines (*rami*) on the upper surface of the thallus but did not intimate that there was any connection between these lines and chambers. Many years later Leitgeb (**7**, p. 308), working mainly on Taylor's species, confirmed his observations and showed that the lines were ridges, representing the boundary-walls of vestigial air chambers. In the vicinity of the apex he was able to demonstrate a short-lived epidermis with distorted pores and he noted that epidermal fragments or isolated cells sometimes persisted for a while on the boundary walls of older chambers. Close to the receptacles he observed the frequent occurrence of elongated papilliform cells in the spaces enclosed by the boundaries and pointed out the homology between these and the green cell-chains filling the air chambers of *Marchantia*.

In the forms which Leitgeb studied these papilliform cells seem to have been restricted to the vicinity of the receptacles. At any rate he made no mention of them in other parts of the thallus, and the figures which he afterwards published (**8**, *pl. 8, f. 8–11*) show a smooth superficial layer of cells. A few years later Spruce (**16**, p. 566) gave a detailed account of "*D. hirsuta*," based primarily on South American material and apparently found a very different state of affairs. According to his description the superficial cells are "papilloso-prominulae" and give the living plants a velvety appearance. If there were exceptions to this condition in any of his plants he did not allude to them. Goebel (**5**, p. 224, *f. 63*) described the surface of "*D. hirsuta*" in much the same way and figured the papilliform cells very clearly. Unfortunately he did not state the source of his material. He contrasted the species with an unnamed form from Ceylon, in which he found vestigial chambers but no surface papillae, this

form thus agreeing essentially with *D. irrigua*, as described by Leitgeb. Soon afterwards Campbell (1, p. 49), in specimens of "*D. trichocephala*," from the Hawaiian Islands, found neither papilliform cells nor vestigial chambers.

The descriptions of Leitgeb, Spruce, Goebel and Campbell thus record the following three types of surface in *Dumortiera:* (1) with both vestigial chambers and papilliform cells; (2) with vestigial chambers but without papilliform cells; (3) with neither vestigial chambers nor papilliform cells. When these types are clearly defined, as they sometimes are, they seem to yield excellent characters for the separation of species, although writers have expressed dissenting views regarding their value. Schiffner, for example, in his description of *D. velutina* (12, p. 26), emphasized the crowded papilliform cells as one of the features of the species, while Stephani claimed that such cells were present in all the species and that their persistence in *D. velutina* merely indicated a shaded environment. Coker (3, p. 226) explained the presence or absence of vestigial chambers in much the same way. In the vicinity of Chapel Hill, North Carolina, he found that plants of *D. hirsuta* growing in shaded, rather dry localities showed such chambers clearly, while plants in more exposed, wet localities were perfectly smooth; and he attributed these differences to environmental factors. Schiffner (14) criticized the views of Stephani and Coker. He maintained that the degree of development which the air chambers exhibited was not directly caused by the environment but that it depended upon inherited qualities. To support his statements he showed that "*D. trichocephala*" (with greatly reduced chambers) and *D. velutina* (with better-developed chambers and papilliform cells), often grew under exactly the same conditions in the primeval forests of Java and Sumatra and that both maintained their distinctive peculiarities. He showed further that plants of *D. velutina* from an almost dark well were exactly the same as those from sunny paths. His most convincing arguments, however, were drawn from plants which had been cultivated under identical conditions for about twenty years in the botanical garden at Prague. These plants represented *D. velutina* and *D. irrigua*, and their distinctive differences persisted unchanged.

Some of Goebel's recent observations (**6**, p. 628, 629) help to confirm Schiffner's deductions. He described a Brazilian *Dumortiera*, presumably a form of *D. hirsuta*, which lacked vestigial air chambers completely and found that none were formed even when the plants were cultivated under the same conditions as *D. velutina*, which developed its normal chambers and papilliform cells. He called attention to the fact that very young plants of *Marchantia* lack air chambers and he therefore interpreted the *Dumortiera* without chambers as a juvenile condition. In case air chambers are never formed there is simply, in his opinion, a persistence of the juvenile state. If air chambers are formed the presence or absence of papilliform cells indicates a greater or less advance beyond the condition without air chambers. In other words there are certain races or varieties or "species" of *Dumortiera* which are never able, even under the most advantageous of conditions, to advance beyond the state without air chambers, while other "species" can advance to various stages beyond this state. Goebel mentioned also a plant of "*D. hirsuta*," which gave rise to an adventive branch without chambers. Since "*D. hirsuta*," in his conception of the species, normally develops chambers, this branch was interpreted as a reversion to a juvenile state.

According to the writer's experience, although the three types of thallus are often distinctly marked, they are by no means invariably so. Even an individual thallus may sometimes bear crowded papilliform cells in an older portion and be smooth or nearly so nearer the apex; another may form vestigial air chambers for a while and then continue its growth without them. Such cases are further examples of reversions and indicate that these may be induced without the intervention of adventive outgrowths. The power to revert, which more or less advanced types thus clearly possess, complicates still further the conditions found in the genus and adds to the difficulty of defining specific limitations. If a form with crowded papillae represents a "species," a smooth form growing in the same area may represent merely a juvenile condition of the same thing or it may represent a "species" which can not advance. At the same time it must be admitted that smooth or nearly smooth states are the only ones which

occur over extensive areas, according to the information at hand. In Europe and Africa, for example, no forms with crowded papilliform cells have as yet been reported, although some of the plants have vestigial chambers while others have none. In such areas, therefore, the difficulties of distinguishing between forms with crowded papillae and smooth forms are eliminated, although the difficulties of distinguishing between forms with air chambers and those without them still remain. In the writer's opinion the latter distinction is less significant than the former, and it seems inexpedient at the present time to attempt to use it in the delimitation of species.

The receptacles of *Dumortiera*, which represent stalked branch-systems, have been repeatedly described (see, for example, Ernst, **4**, pp. 173–178). The stalk of the male receptacle is extremely short but shows two rhizoid-furrows, agreeing in this respect with the much longer stalk of the female receptacle. The disc of the male receptacle is not clearly lobed and the antheridia are not arranged in radiating rows, although they clearly arise in acropetal succession. The disc of the female receptacle develops normally from eight to sixteen groups of archegonia on its lower surface. When the receptacle is young there are no distinct marginal lobes, but these become evident later on in case fertilization has taken place, the groups of archegonia being situated beneath the lobes. The involucre is thick and fleshy and shows a small apical opening; on its surface it bears scattered bristles. Similar bristles, which have been interpreted as modified rhizoids, occur on the upper surface of the disc, sometimes abundantly and sometimes sparingly, sometimes restricted to the marginal portions and sometimes more evenly distributed. Vestigial air chambers are not developed, and the surface-cells, although sometimes more or less convex, do not form papilliform outgrowths, even when the vegetative thallus forms them abundantly.

The features used in separating species have been drawn mainly from the female receptacle and relate more especially to the marginal lobes and the number and distribution of the dorsal bristles. According to Stephani (**25**) the receptacle of *D. trichocephala* is strongly convex and very bristly, while that of *D. hirsuta* is less convex, with the bristles confined to the marginal portions. He

describes further certain ridges or rays on the dorsal surface alternating with the lobes; these ridges branch by forking, the branches extending along the margins of the lobes. In *D. trichocephala* the branches are not connected in any way and thus leave sharp sinuses between the lobes; in *D. hirsuta* the branches are connected by thallus-substance, and the sinuses thus appear lunulate. These distinctions would be very helpful if they were at all constant but, in the writer's experience, this is not the case. All gradations occur between strongly bristly receptacles and those with marginal bristles only, while the ridges with their branches, although sometimes fairly distinct, are often vague and evanescent. Neither is there any correspondence between differences in the thallus and differences in the female receptacle. A smooth or nearly smooth form, for example, may bear receptacles with many bristles scattered over the surface or with only a few bristles restricted to the margin.

The characters assigned to the female receptacle of *D. velutina* seem at first sight to be more trustworthy. According to Schiffner (**12**, p. 26) the disc is depressed-conical with broad lobes and very shallow sinuses, the upper surface bearing few or no bristles. The figures published by Ernst (**4**, *pl. 18, f. 1*) and by Campbell (**2**, *text-f. 3*) represent the upper surface as perfectly smooth, but otherwise agree with Schiffner's description. In material of *D. velutina* from Java, determined by Campbell, the receptacles agree closely with his figures and show no bristles. This is not the case, unfortunately, with the specimens distributed by Schiffner in his Iter Indicum, one of which came from Java (No. 27) and the other from Sumatra (No. 32). In these the immature receptacles are more or less bristly and some of the bristles are scattered over the upper surface. The older receptacles tend to be less bristly, but their marginal sinuses are often deeper than Schiffner's description and the published figures indicate. It would thus appear that the characters assigned to the female receptacle by Schiffner were subject to variation and therefore untrustworthy.

Although the antheridia and archegonia are usually borne on separate receptacles in *Dumortiera*, bisexual receptacles have long been known. They were first described by Taylor (**26**, p. 391)

in *D. irrigua*, where they seem to be somewhat of a rarity. Ernst, however, demonstrated their frequency in Javan specimens of "*D. trichocephala*" (**4**, p. 207). He found them also in *D. velutina* but much more rarely and associated this difference with the prevailingly monoicous inflorescence of "*D. trichocephala*" and the prevailingly dioicous inflorescence of *D. velutina*. Whether or not bisexual receptacles are frequent in American forms of *Dumortiera* remains to be determined.

The spores of *Dumortiera* vary in color from pale to dark brown. The tetrahedral form persists until maturity, although the ridges separating the faces are sometimes difficult to distinguish. The surface-markings are remarkably uniform. Each face bears a series of minute and crowded papillae or short lamellae, which are usually irregularly distributed but which sometimes show a slight tendency to be arranged in short rows. No reticulum is developed. With respect to size statements in the literature are not in accordance. Stephani (**25**) gives a diameter of 25 μ for *D. trichocephala* and of 34 μ for *D. hirsuta;* for *D. velutina* he gives no measurements. Ernst's figures are considerably higher (**4**, p. 178); he gives a length of 45–60 μ and a width of 35–50 μ, without distinguishing between *D. trichocephala* and *D. velutina*. Campbell (**2**, p. 329) states that the spores of *D. trichocephala* are about 20 μ long while those of *D. velutina* are about 29 μ. The writer has examined spores of various forms from widely separated stations and finds that the long diameter measures 20–30 μ, a considerable range being often present in a single capsule. Apparently little help can be obtained from the spores in the separation of species.

The preceding discussion brings out the untrustworthy nature and inconstancy of certain differential characters which have been employed in defining the species of *Dumortiera*. Those drawn from the size and method of branching of the thallus seem especially unreliable. Those drawn from the female receptacle and the spores are scarcely more satisfactory. On the basis of characters drawn from the structural features of the vegetative thallus, the two following species may be distinguished, and these are the only ones which the writer would recognize at the present time:

Upper surface of thallus smooth or nearly so throughout (although often showing vestigial air chambers). 1. *D. hirsuta.*
Upper surface of thallus with crowded papilliform cells, at least in certain portions (always showing vestigial air chambers). 2. *D. nepalensis.*

1. DUMORTIERA HIRSUTA (Sw.) Nees

Marchantia hirsuta Sw. Prodr. Fl. Ind. Occid. 145. 1788.
Dumortiera hirsuta Nees, Nova Acta Acad. Leop.-Carol. **12**: 410. 1824.
Marchantia irrigua Wils.; Hooker, Brit. Fl. **2**: 106. 1833.
Hygropyla irrigua Tayl.; Mackay, Fl. Hibern. **2**: 54. 1836.
Dumortiera irrigua Nees, Naturg. Europ. Leberm. **4**: 159. 1838.
?*Dumortiera hirsuta angustior* G. L. & N. Syn. Hep. 544. 1846.
?*Dumortiera hirsuta intermedia* G. L. & N. *l. c.*
?*Askepos brevipes* Griffith, Not. Pl. Asiat. **2**: 340. 1849.
Dumortiera hirsuta irrigua Spruce, Trans. Bot. Soc. Edinb. **15**: 566. 1885.

It seems unnecessary to give a list of the many specimens which the writer has referred to *D. hirsuta*. They represent a very extensive geographical range, for the most part tropical, and include a few sterile and poorly developed plants, which are not altogether above suspicion. This is especially the case when such plants were found in regions where *D. nepalensis* also occurs. The specimens examined came from the following states, countries, and islands: Pennsylvania, North Carolina, South Carolina, Kentucky, Tennessee, Georgia, Florida, Alabama, Missouri, and Arkansas; Mexico, Guatemala, Nicaragua and Panama; Bermuda; Cuba, Hispaniola, Jamaica, Porto Rico, Montserrat, Guadeloupe, Martinique and Grenada; Colombia, Peru and Bolivia; Venezuela, Brazil and Paraguay; Ireland, England (East Sussex) and France (Hautes-Pyrénées); Madeira and the Canary Islands; Fernando Po and Kamerun; China, India (including Nepal and Ceylon), French Indo-China and Japan; the Philippine Islands, Java and the Hawaiian Islands.

It has unfortunately been impossible to secure the actual type specimen of *Marchantia hirsuta* for examination. The specific name "*hirsuta*" is here associated with the form without surface papillae, because a Swartzian specimen in the British Museum (kindly examined by Mr. Gepp) is smooth and because the

smooth form predominates in the West Indies. Out of over fifty West Indian specimens examined (including fifteen from Jamaica, the type-locality for *M. hirsuta*) only two showed papillae. Of course this evidence is not absolutely conclusive, and if it should ever be proved that the original specimen of *M. hirsuta* represented the papillose form, the synonymy of the species would have to be revised.

There is no such doubt about *Marchantia irrigua*. The Irish specimens of *Dumortiera* are all smooth on the upper surface, with rather vague vestiges of air chambers, and (as Schiffner has shown) never produce papillae even under cultivation. The vars. *angustior* and *intermedia* of the Synopsis need further study. Var. *angustior* was based on Mexican plants with a strongly setulose female receptacle, while var. *intermedia* was based on plants from Peru and South Africa with fewer bristles on the receptacle. Neither of these varieties is known to the writer from authentic material. The same thing is true of Griffith's *Askepos brevipes*, which was based on Indian specimens. Schiffner reduced Griffith's genus to synonymy under *Dumortiera* in 1893 (**9**, p. 35) but has apparently made no definite reference to its single species. According to Griffith's description and figures *A. brevipes* is clearly a *Dumortiera*. It is here referred to *D. hirsuta*, rather than to *D. nepalensis*, on the basis of one of Griffith's specimens in the Mitten Herbarium. This specimen came from Dehra, India, and is labelled "*Askepos*"; the thallus shows a smooth dorsal surface with vestigial air chambers, and the female receptacle bears scattered bristles.

2. DUMORTIERA NEPALENSIS (Tayl.) Nees

Hygropyla nepalensis Tayl. Trans. Linn. Soc. **17**: 392. *pl. 15, f. 2.* 1836.

Marchantia trichocephala Hook. Icon. Pl. *pl. 158.* 1837.

Dumortiera nepalensis Nees, Naturg. Europ. Leberm. **4**: 169. 1838.

Dumortiera trichocephala Nees, *l. c.* **4**: 499. 1838.

Dumortiera hirsuta latior G. L. & N. Syn. Hep. 544. 1846.

Dumortiera hirsuta trichopus Spruce, Trans. Bot. Soc. Edinb. **15**: 567. 1885.

Dumortiera velutina Schiffn. Denkschr. Math.-Naturw. Cl. Kais. Acad. Wiss. Wien **67**: 156. 1899.

Dumortiera calcicola Campbell, Ann. Bot. **32**: 334. *pl. 8 + f. 9.* 1918.

According to the knowledge at hand the range of *D. nepalensis* includes neither Europe nor Africa; otherwise it corresponds pretty closely with that of *D. hirsuta*. In certain parts of its range, such as the southern United States and the West Indies, it has been rarely collected; in other parts of its range, such as southeastern Asia, it seems to be more abundant. The following specimens have been examined:—

GEORGIA: Forest Falls, Decatur County, 1901, *R. M. Harper 1193a* (apparently mixed with *D. hirsuta*).

FLORIDA: Gainesville and vicinity, 1909, *R. M. Harper 13;* 1915, *N. L. T. Nelson 100;* Pineola, 1918, *J. K. Small.*

MEXICO: Honey, Puebla, 1908, *Barnes & Land 520, 526;* Jalapa, Vera Cruz, 1908, *Barnes & Land 564.*

HONDURAS: trail near Rio Platano, 1903, *P. Wilson 682.*

JAMAICA: near Newhaven Gap, 1906, *A. W. Evans 604.*

PORTO RICO: between Adjuntas and Ponce, 1906, *M. A. Howe 1256.*

COLOMBIA: Bogotá, *W. Weir.*

ECUADOR: near Baños, *R. Spruce* (distributed as *D. hirsuta* var. in Hep. Spruceanae).

PERU: Monte Guayrapurina, *R. Spruce* (distributed as *D. hirsuta* var. *trichopus* in Hep. Spruceanae).

VENEZUELA: near Caracas, 1854, *Burchel;* valley of the Rio Limon, Aragua, 1913, *H. Pittier 6070.*

CHINA: Hongkong, collector unknown.

INDIA: Nepal, 1820, *N. Wallich* (type of *Hygropyla nepalensis*); Sikkim-Himalaya, 1889, *Fathers Decoby & Schaul 321* (determined by Schiffner as *D. velutina*).

FEDERATED MALAY STATES: Taiping Hills, 1912, *D. H. Campbell.*

JAPAN: Uzen, 1888, *M. Miyoshi 4;* Tokio, 1898, *K. Miyake 1;* Kioto, *G. Shimadzu & Co. 12.*

PHILIPPINE ISLANDS: Mt. Banjao, Tayabas Province, Luzon, 1907, *F. W. Foxworthy 2395;* Benguet Subprovince, Luzon, 1901,

E. D. Merrill 7901; 1910, *E. Fénix 12814;* 1907, *A. D. A. Elmer 8614;* Bontoc Subprovince, Luzon, 1910, *Father Vanoverbergh 875;* near the Shibuyan River, Davao District, Mindanao, 1904, *E. B. Copeland 985.*

SUMATRA: foot of Mt. Singalang, 1894, *V. Schiffner* (distributed as *D. velutina* in Iter Ind. *32*).

JAVA: Buitenzorg, *F. A. W. Miquel;* same locality, 1894, *V. Schiffner* (distributed as *D. velutina* in Iter Ind. *27*); same locality, 1906, *D. H. Campbell;* Tjibodas, Preanger Province, 1894, *V. Schiffner* (distributed as *D. hirsuta* var. *latior* in Iter Ind. *24*).

BORNEO: Bidi Caves, Bau, Sarawak, 1913, *D. H. Campbell* (type of *D. calcicola*).

HAWAIIAN ISLANDS: without definite localities, *D. Douglas 71* (type of *Marchantia trichocephala*); 1864–70, *H. N. Bolander;* 1876, *J. Bailey 1;* Honolulu, Oahu, 1892, *D. H. Campbell;* Panoa, Oahu, 1895, *A. A. Heller 2330;* Manoa Valley, Oahu, 1917, *D. H. Campbell;* Oahu, 1918, *H. L. Lyon;* West Maui, 1875, *D. D. Baldwin.*

SAMOAN ISLANDS: Utumapa, Upolu, *C. & L. Rechinger* (distributed as *D. velutina* in Krypt Exsic. Mus. Palat. Vindob. *1391*); without definite locality, 1888, *Frances C. Prince.*

The type specimen of *Hygropyla nepalensis* in the Taylor Herbarium shows a thallus with numerous surface papillae associated, as Taylor's figures indicate, with a bristly female receptacle. The type specimen of *Marchantia trichocephala* in the same herbarium shows a thallus with still more numerous papillae and female receptacles which are still more bristly. Both specimens clearly belong to the same specific type. The var. *latior* of *D. hirsuta*, which is listed above in the synonymy, was probably an admixture; it was based on specimens from various parts of the world and may have included forms which would now be referred to the true *D. hirsuta*. The var. *trichopus*, however, is undoubtedly a true synonym of *D. nepalensis*, as the specimens distributed by Spruce clearly indicate.

The last two species which are listed among the synonyms have already been discussed to some extent in the preceding pages. *D. velutina* is distinguished from strongly papillose forms of *D. nepalensis* by certain features of the female receptacle, but

these features (according to the evidence at hand) are too inconstant to be considered of specific value. In *D. calcicola*, as already pointed out, the characters drawn from the size of the thallus and from the sympodia developed by the sexual plants are of little significance. The characters drawn from the immature female receptacles with unfertilized archegonia and from the male receptacles are likewise of doubtful value. Unfortunately the papilliform cells of the thallus are rather scantily developed in the type material, but this condition is often duplicated in undoubted *D. nepalensis*.

For valuable assistance in the preparation of this paper the writer would express his thanks to Professor W. G. Farlow, Professor D. H. Campbell, Dr. Marshall A. Howe and Miss Caroline C. Haynes. Through their generosity it has been possible to study the types of *D. irrigua*, *D. nepalensis*, *D. trichocephala*, *D. dilatata* and *D. calcicola*, as well as other interesting and authentic material.

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LITERATURE CITED

1. **Campbell, D. H.** The structure and development of the mosses and ferns (Archegoniatae). London and New York. 1895.
2. ———. Studies on some East Indian Hepaticae. Ann. Bot. **32**: 319–338. *pl. 8, 9 + f. 1–10.* 1918.
3. **Coker, W. C.** Selected notes. II.—Liverworts. Bot. Gaz. **36**: 225–230. *f. 1–4.* 1903.
4. **Ernst, A.** Untersuchungen über Entwicklung, Bau und Verteilung der Infloreszenzen von *Dumörtiera*. Ann. Jard. Bot. Buitenzorg II. **7**: 153–223. *pl. 18–24.* 1908.
5. **Goebel, K.** Wasserpflanzen. Pflanzenbiologische Schilderungen **2**: 217–386. *pl. 26–31 + f. 63–121.* Marburg. 1893.
6. ———. Organographie der Pflanzen. 2d ed. **2**. Bryophytes. Jena. 1915.
7. **Leitgeb, H.** Ueber die Marchantiaceengattung *Dumortiera*. Flora **63**: 307–312. 1880.
8. ———. Untersuchungen über die Lebermoose. VI. (Schluss)-Heft. Die Marchantieen und allgemeine Bemerkungen über Lebermoose. Graz. 1881.

9. **Schiffner, V.** Marchantiaceae. Engler & Prantl, Nat. Pflanzenfam. 1^3: 16–38. *f. 6–21.* 1893.

10. ———. Ueber exotische Hepaticae. Nova Acta Acad. Caes. Leop.-Carol. **60**: 219–316. *pl. 6–19.* 1893.

11. ———. Ueber einige Hepaticae aus Japan. Oesterr. Bot. Zeitschr. **49**: 385–395. 1899.

12. ———. Die Hepaticae der Flora von Buitenzorg **1**. Leiden. 1900.

13. ———. Neue Materialien zur Kenntniss der Bryophyten der atlantischen Inseln. Hedwigia **41**: 269–294. 1902.

14. ———. Ueber *Dumortiera*. Hedwigia **43**: 428, 429. 1904.

15. ———. Studien über die Rhizoiden der Marchantiales. Ann. Jard. Bot. Buitenzorg II. Suppl. **3**: 473–492. *f. 1–3.* 1909.

16. **Spruce, R.** Hepaticae of the Amazon and of the Andes of Peru and Ecuador. Trans. Bot. Soc. Edinburgh **15**. 1885.

17. **Stephani, F.** Contribuiçoes para o Estudo da Flora d'Africa. Hepaticae. Bol. Soc. Broteria **4**: 1–15. *pl. 1–3.* 1886.

18. ———. Hepaticae africanae. Bot. Jahrb. **8**: 79–95. *pl. 3, f. 1–9.* 1886.

19. ———. Westindische Hepaticae. Hedwigia **27**: 276–302. *pl. 11–14.* 1888.

20. ———. Hepaticae costaricenses. Bull. Soc. Roy. Bot. Belgique **31**: 175–182. 1892.

21. ———. Hepaticarum species novae V. Hedwigia **33**: 1–10. 1894.

22. ———. Hepaticae africanae. Bot. Jahrb. **20**: 299–321. 1895.

23. ———. Hepaticae japonicae. Bull. Herb. Boiss. **5**: 76–108. 1897.

24. ———. Hepaticae sandvicenses. Bull. Herb. Boiss. **5**: 840–849. 1897.

25. ———. *Dumortiera* R. Bl. Nees. [In Species Hepaticarum **1**: 148–151.] Bull. Herb. Boiss. **7**: 222–225. 1899.

26. **Taylor, T.** De Marchanteis. Trans. Linn. Soc. **17**: 375–395. *pl. 12–15.* 1836.

Notes on plants of the southern United States—V

FRANCIS W. PENNELL

KALMIELLA HIRSUTA (Walt.) Small

Sandy scrub-land, between Theodore and Hollanders Island, Mobile County, Alabama, September 3, 1912, *Pennell 4513*.

POLYCODIUM FLORIBUNDUM (Nutt.) Greene

Open pine-land, Biloxi, Harrison County, Mississippi, August 28, 1912, *Pennell 4405*.

SABATIA ELLIOTTII Steud.

Moist scrub-land, between Theodore and Hollanders Island, September 3, 1912, *Pennell 4512*.

Dasystephana tenuifolia (Raf.) Pennell, comb. nov.

Diploma tenuifolia Raf. Fl. Tell. **3**: 27. 1837. "Florida . . . seen in the herb. of Torrey." The type, labeled in Rafinesque's handwriting "G. tenufolia Raf. Monog.," is in the Columbia University Herbarium at the New York Botanical Garden. It bears data of collection, "Florida, Mr. Croom, 1832, flowers white."

In the American Journal of Science for October, 1833 (**25**: 69), H. B. Croom records "Gentiana alba (White flowered Gentian)" as growing in "wet pine woods" in Middle Florida, a region defined as "that tract of country which lies between the Suwanee River on the east, and the Apalachicola on the west." His "observations were chiefly made . . . about twenty miles west of Tallahassee, about thirty miles from the Gulf of Mexico, in latitude about 30° 30′." The plant was seen in bloom January 1–5, 1833, and must certainly be the same species as the plant sent Dr. Torrey.

Dasystephana tenuifolia is most nearly allied to *D. Porphyrio* (Gmel.) Small, long known as *Gentiana angustifolia* Michx. Rafinesque briefly distinguishes the two by certain features, the

most obvious of which is the white corolla of the southern plant. Southern botanical authors treating of the Carolina flora, describe the blue-flowered species, but Chapman, working on the Gulf coast, knew only the white-blooming low-growing plant. A brief contrast of the two would be:

Plant 3–5 dm. tall. Corolla deep-blue within. Stamens and pistil about equaling the tube of the corolla. Stigmas spreading, 3–4 mm. long. Sandy pine-lands, New Jersey to South Carolina. 1. *D. Porphyrio.*

Plant 1–2.5 dm. tall. Corolla white within. Stamens and pistil only about one half the length of the corolla-tube. Stigmas slightly spreading, about 1 mm. long. Low pine barrens, West Florida. 2. *D. tenuifolia.*

Beside the type nearly all the specimens of *D. tenuifolia* seen are from the Chapman Herbarium, and his No. 467b, collected November 2, 1884, and distributed by the Biltmore Herbarium, may be cited. The only specimens of recent collecting which have come to my notice were obtained by Dr. G. C. Fisher at Red Bay, Walter County, Florida, in January, 1917. The same observer has found the plant at Sanborn in Wakulla County. These definite localities enable us to predict the occurrence of the species throughout the low moist pine-lands between Apalachee Bay and Escambia Bay.

Acerates hirtella Pennell, sp. nov.

? *Oligoron longifolium hirsutum* Raf. New Fl. Am. **4**: 60. 1838. No locality given, but description of pedicels as long-hirsute suggests, though it over-emphasizes, a feature of the plant here considered.

Stem 6–10 dm. tall, stout, strongly puberulent in lines above. Leaves scattered, numerous, rather crowded, lanceolate-linear, 9–17 cm. long, 0.6–1.4 cm. wide, scabro-puberulent above and on the veins beneath. Peduncles stout, less than 3 cm. long, scabro-hirtellous. Umbels four to twelve, twenty-five to one hundred flowered. Pedicels 12–15 mm. long, hirtellous with spreading hairs. Flowers 8–8.5 mm. long. Sepals 2 mm. long, lanceolate-acuminate, hirtellous on the back. Petals 5 mm. long, lanceolate, greenish yellow, sometimes slightly purple-tinged on back toward apex, crenulate at apex. Column 0.5–0.7 mm. long. Hoods entire, rounded, one half to two thirds the length of the anthers. Anthers acute, each with two wings which are angled above the

middle. Follicles erect on reflexed fruiting pedicels, 10 cm. long, lanceolate, short-caudate, hirtellous-pubescent. Seeds obovoid, flat, 8 mm. long. Coma silvery, 35 mm. long.

TYPE: dry soil, east of Carthage, Jasper County, Missouri, *F. W. Pennell 5372*, in the herbarium of the University of Pennsylvania.

Wet to dry prairies, northern Illinois to eastern Kansas, and in "swamps" in Michigan. Probably extends to Oklahoma, as Nuttall collected it on the "Red River." This is the plant of the Mississippi Valley which has been merged with the Coastal Plain *A. floridana* (Lam.) A. S. Hitchc., and the following numbers are characteristic, *H. S. Reynolds 28*, *Agnes Chase 1439*, *J. R. Gardner 563*, *B. F. Bush 244*, *A. S. Hitchcock 763*.

The key below contrasts these two species:

Puberulence finely cinereous. Pedicels finely puberulent with incurved hairs. Hoods two thirds to three fourths the length of the anthers. Seeds 9–10 mm. long, dark-brown. Leaves not crowded, narrowly to broadly linear, glabrate. Flowers 7 mm. long. Petals strongly purple externally toward apex, with a narrow white border. Umbels one to six, ten to thirty-flowered, on peduncles reaching 3–9 cm. long. Capsule about 11 cm. long, narrowly lanceolate, long-caudate, finely appressed-puberulent. 1. *A. floridana.*

Puberulence more densely cinereous. Pedicels pubescent with spreading hairs. Hoods one half to two thirds the length of the anthers. Seeds 8 mm. long, cinnamon. Leaves crowded, broadly linear, scabrous to the touch. Flowers 8–8.5 mm. long. Petals greenish, sometimes slightly greenish externally toward apex, with a broader white border. Umbels four to twelve, twenty-five- to one hundred-flowered, on peduncles not over 3 cm. long. Capsule lanceolate, short-caudate, 10 cm. long, hirtellous-pubescent. 2. *A. hirtella.*

EVOLVULUS SERICEUS SW.

Two forms were collected together on black calcareous soil, Edwards Plateau, northwest of New Braunfels, Comal County, Texas, September 14, 1913, *Pennell 5440*, *5442*. No. 5440, with broader densely white-lanate leaves, bore blue corollas; No. 5442, with narrower leaves, strigose-lanate beneath, bore pale blue corollas. The latter is nearer the typical form of the West Indies.

PHLOX FLORIDANA Benth.

Dry sandy pine-land, east of Mississippi City, Harrison County, Mississippi, August 27, 1912, *Pennell 4353*.

EUPLOCA RACEMOSA Rose & Standley

Dry sandy oak-land, west of Sheridan, Colorado County, Texas, September 21, 1913, *Pennell 5516*. This agrees closely with the description of the species of western Texas. It is probably most readily distinguished from *E. convolvulacea* Nutt. by its narrower leaves, lanceolate or nearly so in the specimens seen. Other Texan collections to be referred here are: San Antonio, *E. Palmer 889;* western Texas, *S. B. Buckley*.

VERBENA VENOSA Gill. & Hook.

Moist soil, Mandeville, St. Tammany Parish, Louisiana, August 15, 1912, *Pennell 4204;* moist soil, Catalpa, West Feliciana Parish, August 24, 1912, *Pennell 4332*. Introduced from South America; reported from Houston, Texas, and previously collected in Louisiana in Plaquemines Parish, *A. B. Langlois 49*.

MONARDA PUNCTATA L.

The species is widespread and abundant through most of the Coastal Plain of the southeastern states, occurring inland in the southern Appalachians and westward to Sapulpa, Creek County, Oklahoma, *Pennell 5390*. Two geographical subspecies, which seem worthy of recognition, may be distinguished from the typical form of the species and from each other by the following key:

Leaves lanceolate to ovate-lanceolate, their blades obviously wider proximally and with definite petioles. Corolla conspicuously spotted.
  Stem finely appressed-pubescent. 1. *M. punctata.*
  Stem pubescent with spreading hairs. 1a. *M. punctata villicaulis.*
Leaves linear-lanceolate, obscurely petioled. Corolla not or scarcely spotted. 1b. *M. punctata immaculata.*

1a. **Monarda punctata villicaulis** Pennell, subsp. nov.

Stem pubescent with spreading hairs. Plant usually stouter than in the typical form.

TYPE: dry sandy open soil, Clarke, Lake County, Indiana, collected in flower August 22, 1915, *F. W. Pennell 6412;* in the herbarium of the New York Botanical Garden.

Sandy soil, northern Indiana and northern Illinois; far isolated from the typical species of the Coastal Plain. Other collections seen are:

INDIANA. Kosciusko: Winona, *C. C. Deam 1494;* Lake: Whitings, *N. L. Britton.*

ILLINOIS. Cook: Hyde Park, *A. Chase 1166* (sand near lake); Pullman (Y).

1*b*. **Monarda punctata immaculata** Pennell, subsp. nov.

Stem pubescent with fine reflexed appressed hairs. Leaves linear-lanceolate, obscurely petioled. Corolla not or scarcely spotted.

TYPE: sandy soil, Aloe, Victoria County, Texas, collected in flower September 8, 1913, *F. W. Pennell 5494;* in the herbarium of the University of Pennsylvania; iso-type in the herbarium of the New York Botanical Garden.

Also seen from Texas, without locality, collected by Charles Wright.

CLINOPODIUM COCCINEUM (Nutt.) Kuntze

Dry sandy pine-land, Biloxi, Harrison County, Mississippi, August 27, 1912, *Pennell 4372;* also Mississippi City, Harrison County, *Pennell 4355*.

Dry sandy ridges in the longleaf pine-land, southern Georgia and northern Florida to southern Mississippi.

NEW YORK BOTANICAL GARDEN.

INDEX TO AMERICAN BOTANICAL LITERATURE

1905–1919

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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Artschwager, E. F. Histological studies on potato leafroll. Jour. Agr. Research **15**: 559–570. *pl.* C, *35–45*. 9 D 1918.

Ballard, W. R. Methods and problems in pear and apple breeding. Maryland Agr. Exp. Sta. Bull. 196: 79–92. *f. 1–3*. Ap 1916.

Beach, W. S. Biologic specialization in the genus *Septoria*. Am. Jour. Bot. **6**: 1–33. *pl. 1* + *f. 1–13*. 1 F 1919.

Bergman, H. F. Flora of North Dakota. N. Dakota Soil & Geol. Surv. Bien. Rep. **6**: 151–372. [1912].

Berry, E. W. *Eucalyptus* never present in North America. Science II. **49**: 91, 92. 24 Ja 1919.

Bioletti, F. T. The seedless raisin grapes. Calif. Agr. Exp. Sta. Bull. 298: 75–86. S 1918.

Booth, N. O. Some phases of pollination. Proc. Soc. Hort. Sci. **1906**: 20–26. Mr 1908.

Bower, F. O. Botanical research in the United Kindgom during the war. Am. Jour. Sci. **47**: 117–122. F 1919.

Brewster, W. Exotic plants established in Middlesex County, Massachusetts. Rhodora **20**: 204, 205. 27 Ja 1919.

Britton, N. L. John Adolph Shafer. Mem. Soc. Cubana Hist. Nat. "Felipe Poey" **3**: 225–228. 1918.

Burt, E. A. The Thelephoraceae of North America—X. *Hymenochaete*. Ann. Missouri Bot. Gard. **5**: 301–370. *pl. 16, 17* + *f. 1–32*. N 1918.

Churchill, J. R. A smooth-fruited form of *Asclepias syriaca*. Rhodora **20**: 206, 207. 27 Ja 1919.

Clark, B. O. The so-called pineapple disease. Hawaiian Forest. & Agr. **2**: 166–173. Ja 1905.

Clark, V. A. Light as a factor in plant culture: the problem stated and its method of solution. Proc. Soc. Hort. Sci. **1905**: 24–32. Mr 1908.

Close, C. P. Immediate effect of cross pollination on apples. Proc. Soc. Hort. Sci. **1907**: 47–51. Mr 1908.

Clute, W. N. Flowers that are not flowers. Gard. Chron. Am. **23**: 49, 50. F 1919.

Craig, A. G. Mendel's law applied in tomato breeding. Proc. Soc. Hort. Sci. **1907**: 24–27. Mr 1908.

Dreschsler, C. Morphology of the genus *Actinomyces*—I. Bot. Gaz. **67**: 65–83. 18 Ja 1919.

East, E. M. Technique of hybridizing the potato. Proc. Soc. Hort. Sci. **1907**: 35–40. Mr 1908.

Fairchild, D. Byron David Halsted, botanist. Phytopathology **9**: 1–6. Ja 1919. [Portrait].

Farrington, E. I. Cut flowers and how to use them. Jour. N. Y. Bot. Gard. **19**: 311–314. D 1918.

Fenn, W. O. The effects of electrolytes on gelatin and their biological significance—I. The effects of acids and salts on the precipitation of gelatin by alcohol. Jour. Biol. Chem. **33**: 279–294. *f. 1–5*. F 1918;—II. The effects of salts on the precipitation of acid and alkaline gelatin by alcohol. Antagonism. Jour. Biol. Chem. **33**: 439–451. *f. 1–6*. 1918;—III. The effects of mixtures of salts on the precipitation of gelatin by alcohol. Antagonism. Jour. Biol. Chem. **34**: 141–160. *f. 1–9*. Ap 1918.

Fernald, M. L. Some North American representatives of *Braya humilis*. Rhodora **20**: 201–203. 27 Ja 1919.

Forbes, C. N. The genus *Lagenophora* in the Hawaiian Islands, with descriptions of new species. B. P. Bishop Mus. Nat. Hist. Occasional Papers 6: 55–62. *pl. 1–4*. 1918.
Lagenophora Erici and *L. Helena*, spp. nov. are described.

Fred, E. B. The effect of certain organic substances on seed germination. Soil Sci. **6**: 333–350. *pl. 1–4.* N 1918.

Gale, W. F. Some experiments with *Fucus* to determine the factors controlling its vertical distribution. Puget Sound Biol. Sta. Publ. 2: 139–150. *Chart 1.* 26 D 1918.

Gardner, N. L. New Pacific coast marine algae—IV. Univ. Calif. Publ. Bot. **6**: 487–496. *pl. 42.* 4 Ja 1919.
Includes new species in *Anabaena* (1), *Codium* (1), *Rhizoclonium* (1), *Hormiscia* (1).

Gates, R. R. A new evening primrose. *Oenothera Novae-Scotiae.* Trans. Nova Scotian Inst. Sci. **14**: 141–145. *f. 1, 2.* 1 Au 1918.

Gilbert, A. H., & Myer, D. S. Stem rot of clovers and alfalfa as a cause of "clover sickness." Kentucky Agr. Exp. Sta. Circ. 8: 46–60. *pl. 1, 2.* S 1915.

Gunthorp, H. Hay-fever and a national flower. Science II. **49**: 147, 148. 7 F 1919.

Harris, J. A. On a chemical peculiarity of the dimorphic anthers of *Lagerstroemia indica*, with a suggestion as to its ecological significance. Ann. Bot. **28**: 499–507. *f. 1, 2.* Jl 1914.

Harris, J. A. The size of the seed planted and the fertility of the plant produced. Am. Breeders Mag. **3**: 293–295. 1912.

Harter, L. L. The control of malnutrition diseases of truck crops. Virginia Truck Exp. Sta. Bull. 1: 4–16. *f. 1–4.* 24 S 1909.

Hartley, C., Merrill, T. C., & Rhoads, A. S. Seedling diseases of conifers. Jour. Agr. Research **15**: 521–558. *pl.* B. 9 D 1918.

Hayata, B. *Protomarattia*, a new genus of Marattiaceae, and *Archangiopteris*. Bot. Gaz. **67**: 84–92. *pl. 1* + *f. 1–3.* 18 Ja 1919.
Protomarattia tonkinensis, Archangiopteris subintegra, and *A. tamadaoensis,* spp. nov., are described.

Haynes, C. C. Sullivant Moss Society exchange list of Hepaticae found in the United States, Canada, and Arctic America. Bryologist **21**: 87–90. 15 Ja 1919.

Hedrick, U. P., & Booth, N. O. Mendelian characters in tomatoes. Proc. Soc. Hort. Sci. **1907**: 19–24. Mr 1908.

Hendrickson, I. S. *Gladioli.* Jour. Internat. Gard. Club **2**: 570–580. D 1918. [Illust.]

Holbert, J. R., Trost, J. F., & Hoffer, G. N. Wheat scab as affected by systems of rotation. Phytopathology 9: 45–47. 20 Ja 1919.

Jennings, O. E. An annotated list of the Pteridophytes of northwestern Ontario. Am. Fern Jour. **8**: 38–50. *pl. 3.* Je 1918.

J[ennings], O. E. Certain organic substances assimilated by *Ceratodon purpureus*. Bryologist **21**: 86. 15 Ja 1919.

Johnson, D. S. The fruit of *Opuntia fulgida*. A study of perennation and proliferation in the fruits of certain Cactaceae. 1–62. *pl. 1–12 + frontispiece*. 25 O 1918.
Carnegie Inst. Washington, Publ. 269.

Judd, C. S. The Hawaiian sumach. Hawaiian Forest. & Agr. **15**: 441, 442. N 1918.

Kisselbach, T. A., & Ratcliff, J. A. Oats investigations. Nebraska Agr. Exp. Sta. Bull. 160: 1–48. *f. 1–17*. 15 N 1917.

Knowlton, C. H., & Deane, W. Reports on the flora of the Boston District,—XXVIII. Rhodora **20**: 164–171. 4 S 1918;—XXIX. Rhodora **20**: 208, 209. 27 Ja 1919.

Knowlton, F. H. Note on a recent discovery of fossil plants in the Morrison formation. Jour. Washington Acad. Sci. **6**: 180, 181. 4 Ap 1916.

Koch, G. P., & Butler, J. R. Cross-inoculation of legumes. Soil Sci. **6**: 397–403. N 1918.

Lauritzen, J. I. The relation of temperature and humidity to infection by certain fungi. Phytopathology **9**: 7–35. 20 Ja 1919.

Lee, H. A. Further data on the citrus canker affection of the citrus species and varieties at Lamao. Philip. Agr. Rev. **11**: 200–206. *pl. 9–15*. 1918.

León, H. Las exploraciones botanicas de Cuba. Reseña comparativa de la contribución du Dr. N. L. Britton y de los botánicos anteriores, al conocimiento de la flora Cubana. Mem. Soc. Cubana Hist. Nat. "Felipe Poey" **3**: 178–224. 1918. [Illust.]

Lunnell, J. Enumerantur plantaę Dakotae septentrionalis vasculares —XIV. Am. Mid. Nat. **5**: 233–241. N 1918.

Lutman, B. F. Apple diseases and their control. Vermont Comm. Agr. Rept. **9**: 67–70. 1918.

Lutman, B. F. Blight disease of potatoes. Ann. Rept. Vermont Hort. Soc. **13**: 55–60. 1916.

MacCaughey, V. An ecological survey of the Hawaiian Pteridophytes. Jour. Ecol. **6**: 199–219. N 1918.

MacKay, A. H. The phenology of Nova Scotia, 1916. Trans. Nova Scotian Inst. Sci. **14**: 147–154. 1 Au 1918. [Illust.]

Massey, L. M. More about rose diseases. Am. Rose Ann. **1918**: 63–71. *pl. 4 + f. 1*. 1918.

Posada Arango, A. Estudios cientificos del Doctor Andres Posada. 1–432. Medellin. 1909.

Includes *Garciamedinea* and *Dimorphylia*, gen. nov., and 18 new species in various genera.

Renacco, R. Sobre algunas enfermedades parasitarias de las plantas cultivadas. An. Soc. Cien Argentina **81**: 62–70. 1916.

Riós, P. G. La producción de nuevas variedades de cana. Rev. Agr. Puerto Rico **2**: 29–38. *f. 1–8.* D 1918.

Roig, J. T. Breve reseña sobre una excursion botanica a oriente. Mem. Soc. Cubana Hist. Nat. "Felipe Poey" **3**: 168–175. 1918.

Seaver, F. J. Possibilities of the truffle industry in America. Jour. N. Y. Bot. Gard. **19**: 307–309. *pl. 223.* D 1918.

Shapovalov, M. Some potential parasites of the potato tuber. Phytopathology **9**: 36–42. *pl. 2, 3 + f. 1, 2.* 20 Ja 1919.

Shear, C. L., Stevens, N. E., & Rudolph, B. A. Observations on the spoilage of cranberries due to lack of proper ventillation. Mass. Agr. Exp. Sta. Bull. 180: 235–239. [1918.]

Stahel, G. De Zuid-Amerikaansche Hevea-bladziekte veroorzaakt door *Melanopsammopsis Ulei* nov. gen. (= *Dothidella Ulei* P. Hennings). Dept. Landbouw Suriname Bull. 34: 1–111. *pl. 1–28 + f. 1–3.* Je 1917.

Stevens, H. E. Citrus canker. Florida Agr. Exp. Sta. Bull. 122: 113–118. *f. 43–46.* Mr 1914.

Stevenson, J. A. Catalogo de las enfermedades fungosas y no-parasiticas que atacan las plantas economicas de Puerto Rico. Rev. Agr. Puerto Rico **2**: 19–27. D 1918.

Stevenson, J. A. La enfermedad del mosaico de tabaco. Rev. Agr. Puerto Rico **2**: 39–44. D 1918.

Stewart, A. A consideration of certain pathologic conditions in *Ambrosia trifida.* Am. Jour. Bot. **6**: 34–46. *pl. 2 + f. 1.* 1 F 1919.

Stout, A. B. Notes on an experiment with potash. Jour. N. Y. Bot. Gard. **19**: 309–311. D 1918.

Swingle, D. B., & Morris, H. E. Plum pocket and leaf gall on American plums. Montana Agr. Exp. Sta. Circ. 77: 153–164. *f. 1–6.* F 1918.

Taft, L. R. Breeding for the prevention of little peach. Proc. Soc. Hort. Sci. **1907**: 40–42. Mr 1908

Taylor, R. H. The almond in California. Calif. Agr. Exp. Sta. Bull. 297: 1–72. *f. 1–28.* Au 1918.

Temple, C. E. Report of the state pathologist. Maryland Agr. Soc. Rep. **2**: 161–169. 1 Mr 1918.

Victorin, M. Random botanical notes—II. L'Islet County, Quebec. Ottawa Nat. **32**: 109–111. D 1918. [Illust.]

Vries, H. de. *Oenothera rubrinervis*, a half mutant. Bot. Gaz. **67**: 1–26. 18 Ja 1919.

Waksman, S. A., & Curtis, R. E. The occurrence of *Actinomycetes* in the soil. Soil Sci. **6**: 309–319. O 1918.

Weatherby, C. A. *Pellaea microphylla* Mett. ex Kuhn. Am. Fern Jour, **8**: 104–108. *pl. 5*. 20 Ja 1919.

Wenrich, D. H. *Stylonichia* impaled upon a fungal filament. Science II. **48**: 602–604. 13 D 1918.

White, E. A. Methods of rose-breeding. Am. Rose Ann. **1918**: 51–55. *f. 1–7*. 1918.

Wicks, W. H. The effect of cross-pollination in size, color, shape and quality of the apple. Month. Bull. State Comm. Hort. Calif. **7**: 568–573. O 1918.

Wicks, W. H. Variety study of the Irish potato. Arkansas Agr. Exp. Sta. Bull. 137: 1–32. *f. 1–23*. N 1917.

Wille, N. Om stammens og bladets bygning hos *Myriocarpa cordifolia* Liebm. Biol. Arbej. Til. Eug. Warming 265–279. 3 S 1911.

Williams, R. S. Notes on some western lichens. Bull. Torrey Club **46**: 21–25. 20 Ja 1919.

Wilson, E. H. Vegetation of Korea. Jour. Internat. Gard. Club **2**: 597, 598. D 1918.

[**Woods, F. A.**] Bee keeping may increase the cotton crop. Jour. Heredity **9**: 282–285. *f. 16, 17*. 13 N 1918.

[**Woods, F. A.**] China's trees and ours strikingly alike. Jour. Heredity **9**: 272–281. *f. 9–15*. 13 N 1918.

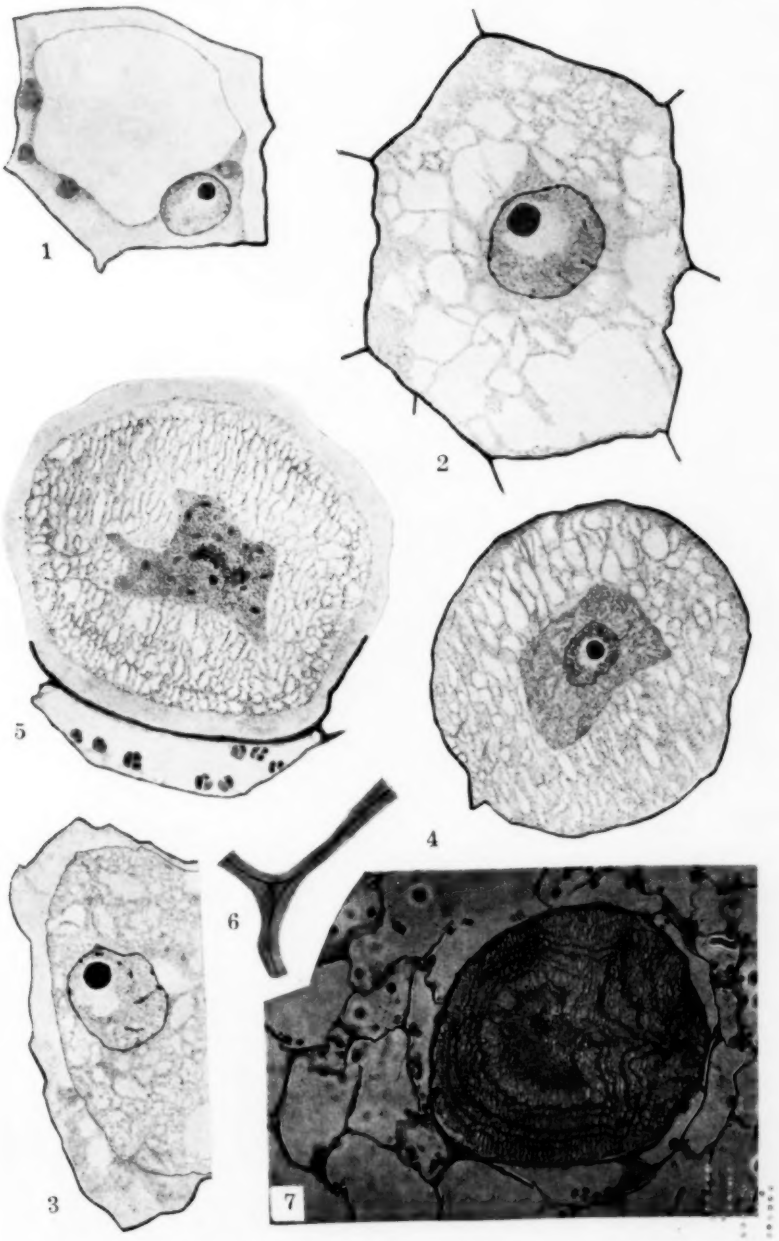
Wooton, E. O. Certain desert plants as emergency stock feed. U. S. Dept. Agr. Bull. 728: 1–27. *pl. 1–8*. 18 D 1918.

Wortley, E. J. Potato leaf-roll: its diagnosis and cause. Phytopathology **8**: 507–529. *f. 1–16*. O 1918.

Yates, H. S. Fungi from British North Borneo. Philip. Jour. Sci. **13**: (Bot.) 233–240. Jl 1918.

Includes new species in *Meliola* (2), *Hypocrea* (1), *Phaeodothiopsis* (1), and *Phyllosticta* (1).

York, H. H., & Spaulding, P. The overwintering of *Cronartium ribicola* on *Ribes*. Phytopathology **8**: 617–619. D 1918.



STEWART: MUCILAGE OR SLIME FORMATION IN THE CACTI